International Journal of Inventive Engineering and Sciences (IJIES)
ISSN: 2319-9598 (Online), Volume-9 Issue-1, December, 2021

Optical BPSK Modulation and Demodulation using Opti System Simulator

Rashmi Rekha Mishra, Karmila Soren

Abstract: Fibre optics deals with study of propagation of light through transparent dielectric waveguides. The fibre optics is used for transmission of data from point to point location. Fibre optic systems currently used are most extensively as the transmission line between terrestrial hardwired systems. The carrier frequencies used in conventional systems had the limitations in handling the volume and rate of the data transmission. Greater the carrier frequency larger is the available bandwidth and information carrying capacity. This paper explains about Optical BPSK, where input data is converted to BPSK data which is optically modulated by optical modulator and transmitted through an optical fibre cable. The transmitted data and received data are compared in the end.

Keywords: Optical Fibre, BPSK, MZ Modulator, PIN Photodiode, 3R Regenerator.

I. INTRODUCTION

An optical fiber is a thin, flexible, transparent fiber that acts as a waveguide, or "light pipe", to transmit light between the two ends of the fire. Optical fibers are widely used in Fiber-optic communications, which permits transmission over longer distances and at higher bandwidths (data rates) than other forms of communication [1]. Fibers are used instead of metal wires because signals travel along them with less loss and are also immune to electromagnetic interference. It works on the principle of total internal reflection. The basic components are light signal transmitter, the optical fiber, and the photo detecting receiver shown in Fig.1. The basic principles are the same whatever the system. In the system the transmitter of light source generates a light stream modulated to enable it to carry the data conventionally a pulse of light indicates a "1" and the absence of light indicates "0" [2]. This light is transmitted down a very thin fiber of glass or other suitable material to be presented at the receiver or detector. The detector converts the pulses of light into equivalent electrical pulses [3-4]. In this way the data can be transmitted as light over great distances. For optical transmission laser diodes are often directly modulated. This provides a very simple and effective method of transferring the data onto the optical signal. This is achieved by controlling current applied directly to the device.

Manuscript received on December 18, 2021.
Revised Manuscript received on December 24, 2021.
Manuscript published on December 30, 2021.
* Correspondence Author
Rashmi Rekha Mishra*, Department of I & E, College of Engineering and Technology, Bhubaneswar (Odisha), India. E-mail: rashmirekhamishra119@gmail.com
Karmila Soren, Department of I & E, College of Engineering and Technology, Bhubaneswar (Odisha), India. E-mail: ksoren@cet.edu.in

This in turn varies the light output from the laser. However for very high data rates or very long distance links, it is more effective to run the laser at a constant output level (continuous wave). The light is then modulated using an external device. The advantage of using an external means of modulation is that it increases the maximum link distance because an effect known as laser chirp is eliminated. This chirp broadens the spectrum of the light signal and this increases the chromatic dispersion in the fiber optic cable.

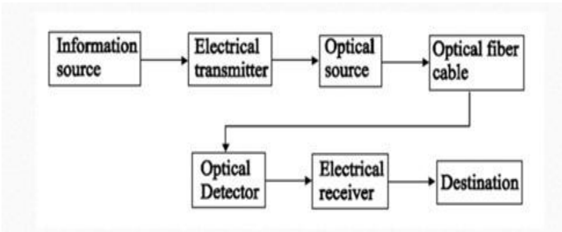

Fig.1: Block diagram of Optical Fibre Communication

A fibre optic cable consists of core, around which is another layer referred to as the cladding. Outside of this there is a protective outer coating. The fibre optic cables operate because their cladding has a refractive index that is slightly lower than that of the core. This means that light passing down the core undergoes total internal reflection when it reaches the core / cladding boundary, and it is thereby contained within the core of the optical fibre [5].Light travelling along a fibre optic cable needs to be converted into an electrical signal so that it can be processed and the data that is carried can be extracted. The component that is at the heart of the receiver is a photo-detector. This is normally a semiconductor device and may be a p-n junction, a p-i-n photo-diode or an avalanche photo-diode. Photo-transistors are not used because they do not have sufficient speed. Once the optical signal from the fibre optic cable has been applied to the photo-detector and converted into an electrical format it can be processed to recover the data which can then be passed to its final destination [6]. Fibre optic transmission of data is generally used for long distance telecommunications network links and for high speed local area networks. Currently fibre optics is not used for the delivery of services to homes, although this is a long term aim for many Telco's. By using optical fibre cabling here, the available bandwidth for new services would be considerably higher and the possibility of greater revenues would increase. Currently the cost of this is not viable, although it is likely to happen in the medium term. PSK is the digital modulation technique in which the phase of the carrier signal is changed by varying the sine and cosine inputs at a particular time.

PSK technique is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications [7]. PSK is of two types depending upon the phases the signal gets shifted. BPSK is also called as 2-phase PSK or Phase Reversal Keying. In this technique, the sine wave carrier takes two phase reversals such as 0° and 180° [8]. BPSK is basically a Double Side Band Suppressed Carrier (DSBSC) modulation scheme, for message being the digital information. The block diagram of Binary Phase Shift Keying consists of the balance modulator which has the carrier sine wave as one input and the binary sequence as the other input. The diagrammatic representation is shown in Fig.2.

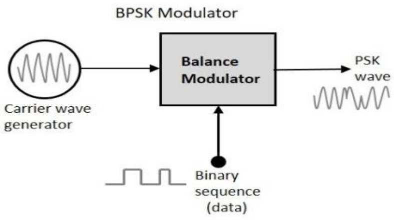

Fig.2: BPSK Modulator

The modulation of BPSK is done using a balance modulator, which multiplies the two signals applied at the input. For a zero binary input, the phase will be 0° and for a high input, the phase reversal is of 180° [9].BPSK demodulator consists of a mixer with local oscillator circuit, a band pass filter, a two-input detector circuit [10]. The diagram is as follows.By recovering the band-limited message signal, with the help of the mixer circuit and the band pass filter, the first stage of demodulation gets completed. The base band signal which is band limited is obtained and this signal is used to regenerate the binary message bit stream.In the next stage of demodulation, the bit clock rate is needed at the detector circuit to produce the original binary message signal. If the bit rate is a sub-multiple of the carrier frequency, then the bit clock regeneration is simplified. To make the circuit easily understandable, a decision-making circuit may also be inserted at the 2nd stage of detection.

II. SYSTEM MODEL

Optical BPSK system model is shown in the Fig.3

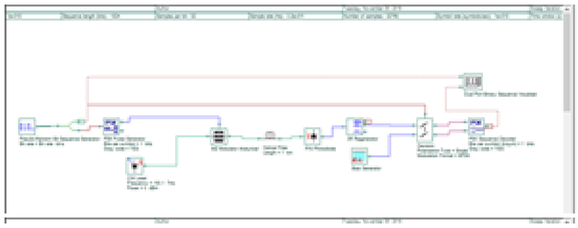

Fig.3: Layout of Optical BPSK Modulation and Demodulation

It is designed by using the following components which are as follows:

PRBS (Pseudo Random Bit Sequence Generator): It generates a Pseudo Random Binary Sequence (PRBS) according to different operation modes. The bit sequence is designed to approximate the characteristics of random data.

Fork: It copies the input signals into two output signals. This tool allows us to duplicate component output ports.

PSK Pulse Generator: It generates two parallel M-ary electrical signals from binary signals using Phase Shift Keying (PSK) Modulation. Bits per symbol=1 bit and phase offset =0 degree.

CW Laser: It generates a continuous wave (CW) optical signal. Here Frequency = 193.1 THz and power =0dBm.

MZ Modulator Analytical:It stimulates Mach- Zehnder Modulator using an analytical model.

Optical Fiber:It stimulates the propagation of an optical field in a single-mode fiber with dispersive and non-linear effects taken into account. Reference wavelength = 1550nm, length =1Km and attenuation = 0.2dB/Km.

PIN Photodiode:It is used to convert an optical signal into an electrical current based on this device's Responsively.

3R Generator:It generates an electrical signal.

Bias Generator:It's a dc source.

Decision:This process the electrical signal received from 3R Regenerator and normalizes the electrical amplitude of each I and Q channel to respective m-PSK. Here we have used BPSK.

PSK Sequence Decoder:It decodes the input M-ary (BPSK) sequence and retrieve the original transmitted signal.

Dual Port Oscilloscope visualize: It allows the user to calculate and display electrical signal in the time domain. It can simultaneously view two electrical signal inputs.

Table .1: Components summary

Name of the components	Port type	Signal type
PRBS	Output	Binary
Fork	I. Input II. Output III. Output	• Binary • Binary • Binary
PSK Pulse Generator (Bits /symbol = 1 bit and phase offset =0 degree)	I. Input II. Output	• Binary • Electrical
CW Laser (frequency= 193.1 Thz and power = 0dBm)	Output	Optical

Retrieval Number: 100.1/ijies.C1045126321
DOI: 10.35940/ijies.C1045.129121
Journal Website: www.ijies.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

MZ Modulator Analytical	I. Input (Message Signal) II. Output (Carrier signal) III. Output (Modulated output)	• Electrical • Optical • Optical
Optical fiber (Reference wavelength = 1550nm, Length= 1Km and attenuation=0.2dB/Km)	I. Input II. Output	• Optical • Optical
PIN Photodiode	I. Input II. Output	• Optical • Electrical
3R Generator	I. Input II. Output	• Electrical • Electrical
Bias Generator	Output	Electrical
Decision(Modulation Format– BPSK)	I. Input (Reference binary signal) II. Input I-X III. Input Q-X IV. Output I-X V. Output Q-X	• Binary • Electrical • Electrical • BPSK • BPSK
PSK Sequence Generator	I. Input I-X II. Input Q-X III. Output	• BPSK • BPSK • Binary
Dual Port Oscilloscope Visualizer	I. Input (Transmitted) II. Input(received)	• Electrical • Electrical

III. RESULTS AND ANALYSIS

The entire experimental layout is designed using OptiSystem 16.0. The transmitted and received signals through optical BPSK modulation have been compared as shown in the Fig.4 and Fig.5 with (input data_1 as (01010010101100011100) and input data_2 as (00011110011110110110) respectively. Also random sequences are examined and compared accordingly.

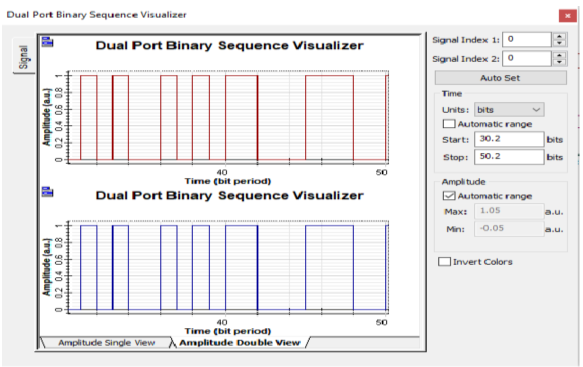

Fig.4: Transmitted and Received data_1

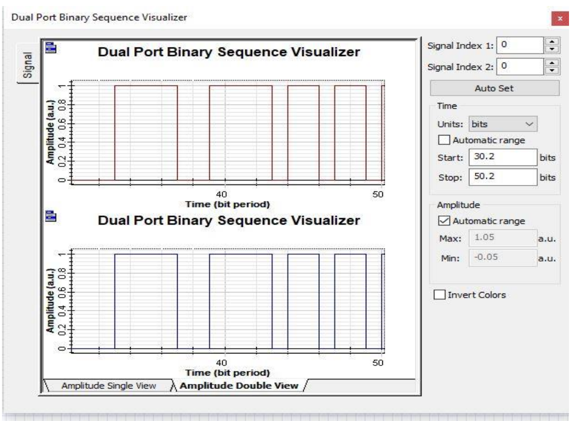

Fig.5: Transmitted and Received data_2

IV. CONCLUSION

The input data is transmitted by BPSK modulation through optical fibre oflength 1Km, data rate 10GBPS and attenuation of 0.2dB/Km. The transmitted data is received successfully at the receiver side. We can transmit the data at high data rate. By increasing the attenuation of optical channel will hamper the output waveforms. We can also send multiple data simultaneously through the same optical fibre cable using BPSK.Other digital modulation techniques can be performed and compared for transmitting the digital data. We can use different types of filters to reduce the attenuation effect.

REFERENCES

1. H Li, Y Ling, Y Yin,, H Zhou, K Qiu, "High-Extinction-Ratio periodic pulse signal generation based on MZ modulator", 16th International Conference on Optical Communications and Networks (ICOCN), December 2017.
2. T.G Gaillorenzi, "Optical communications research and technology: Fiber Optics", In Proceeding of IEEE, vol.66, pp.744-780, July 1978.
3. A Gangwar, B Sharma, "Optical Fiber: The new era of high speed communication (Technology, Advantages and Future aspects)", International Journal of Engineering Research and Development, vol.4, pp.19-23, October 2012.
4. Steward E. Miller, Enrique A. J. Marcatili, AndTingye Li "Research Toward Optical-Fiber Transmission Systems"Vol.16, No.12, December 2012.
5. K. Mishina, A. Maruta, S. Mitani, T. Miyahara, K. Ishida, K. Shimizu,T. Hatta, K. Motoshima, and K. Kitayama, "All-optical format conversion from NRZ-OOK to RZ-BPSK using SOA-MZI wavelength converter,"InProc. Optical Fiber Communication (OFC), 2006.
6. Ken Mishina, Akihiro Maruta, Shun sukeMitani , "NRZ-OOK-to-RZBPSK Modulation Format Conversion Using SOA-MZI Wavelength,"Journal of Lightwave Technology, vol.24, pp.3751-3758,2006.
7. M. L Hossain, A Rahim, "Design and Implementation a BPSK Modem and BER Measurement in AWGN Channel",International Journal of Scientific and Research Publications, Vol. 8, May 2018.
8. S.Trong, D Sun,"Direct Demodulation ofOptical BPSK/QPSK Signal", August 24, 2018.

9. A LEVEN, N KANEDA, “Coherent receivers for practical optical communication systems”, InProceedings of IEEE Conference on Optical Fiber Communication and the National Fiber Optic Engineers Conference, August 2007.
10. T SAKAMOTO, A CHIBA, A KANNO, “Real-time homodyne reception of 40-Gb/s BPSK signal by digital Opticalphase-locked loop”, In 36th European Conference and Exhibition on Optical Communication (ECOC). Torino (Italy), 2010.

AUTHORS PROFILE

Rashmi Rekha Mishra, Completed B.Tech in I& EE from College of Engineering and Technology, Bhubaneswar, Odisha in 1997 and M.Tech (EIS) from Berhampur University , Odisha in 2015. (IEEE member). Working as a faculty in Odisha University of Technology & Research, Bhubaneswar, Odisha.

Karmila Soren, Completed B.Tech (E & IE) from Institute of Technical Education and Research, Bhubaneswar, Odisha in 2010 and M.Tech. from National Institute of Technology, Rourkrla, Odisha .Working as an Asst. Prof. in Odisha University of Technology & Research, Bhubaneswar, Odisha.

Retrieval Number: 100.1/ijies.C1045126321
DOI: 10.35940/ijies.C1045.129121
Journal Website: www.ijies.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)